Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Technologies	)	ET Docket No. 03-108

SPRINT REPLY COMMENTS

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Sprint Corporation hereby replies to the comments filed in response to the Federal Communications Commission's ("FCC" or "Commission") Notice of Proposed Rulemaking concerning deployment of cognitive radio technologies.[1]

I. INTRODUCTION AND SUMMARY

Cognitive radio technologies have shown utility in controlled settings where they can be designed and manufactured to achieve specific operational functions. Dual-mode handsets employed in various Commercial Mobile Radio Services ("CMRS") systems that change frequencies and modulation schemes, and Code-Division Multiple Access ("CDMA") system handsets that adjust their power based upon overall cell utilization are examples of cognitive radio technologies that allow licensees to more efficiently manage and utilize their licensed spectrum. The benefit of these technologies is that they allow licensees to control their operating parameters and thus manage and control interference within their spectrum, further promoting intensive, efficient spectrum use.

[1] *See Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies,* ET Docket 03-108, *Notice of Proposed Rulemaking and Order,* FCC 03-322, 18 FCC Rcd 26859 (Dec. 30, 2003), *summarized in* 69 Fed. Reg. 7397 (Feb. 17, 2004)("NPRM").

The utility of cognitive radio technologies is lost, however, in autonomous settings where incumbent licensees have no ability to control these technologies and their use. Accordingly, Sprint agrees with the many commenters who oppose non-voluntary spectrum "sharing" in licensed bands. As the record in the Interference Temperature (ET Docket No. 03-237) proceeding makes clear, unlicensed cognitive radio technologies are technically incapable of non-voluntary spectrum "sharing" in licensed bands. Instead, Sprint submits that cognitive radio technologies should be explored as an effective mechanism to implement – from a technological standpoint – the operational terms and conditions of access to licensed spectrum through secondary market leasing arrangements, where appropriate.

Further, Sprint opposes any general increases in the power limits adopted for unlicensed devices under Part 15 of the FCC's rules, such as increases to the radiated emissions limits set forth under Rule 15.209. There is no record justification for such action, which would raise serious interference risks for licensees throughout the electromagnetic spectrum. Finally, assuming *arguendo* that the Commission proceeded to authorize cognitive radios as proposed in the NPRM, in all events it must adjust those rules so that the out-of-band emissions of cognitive radio devices operating under Rule 15.247 are no greater than what is currently allowed for non-cognitive devices under that rule section. The Commission's rationale for permitting cognitive radios to operate at higher overall in-band power levels is predicated solely upon *in-band* spectrum occupancy and is wholly unrelated to *out-of-band* activities. Forcing adjacent spectrum licensees to accept higher out-of-band emissions from these unlicensed devices could result in harmful interference to licensees and would amount to arbitrary and capricious rule-making, contrary to law.

II. NON-VOLUNTARY SPECTRUM SHARING BY COGNITIVE RADIOS SHOULD NOT BE PERMITTED

Sprint agrees with the various commenters that oppose the use of cognitive radio technologies to enable non-voluntary third party access to spectrum.[2] While cognitive radio technologies provide significant utility for organizing and managing spectrum use in settings in which the licensee controls the operational parameters of the cognitive radio device, such as CMRS handsets and, potentially, in the context of implementing secondary market leasing activities, the technology has not been shown to be capable of operating without causing interference to licensed services in non-voluntary, unlicensed settings in which in-band licensees have no control over the operation of the cognitive radio devices. To the contrary, as the record recently compiled in the Interference Temperature proceeding makes clear, cognitive radio technologies are technically incapable of non-voluntary spectrum "sharing" in licensed CMRS and certain fixed service bands on a non-interference basis.[3] To illustrate these technical problems, Sprint appends as Attachment A a technical analysis prepared for the Interference Temperature pro-

[2] *See, e.g.*, Wireless Coalition Association International ("WCA") Comments at 4-11; Cellular Telecommunications & Internet Association ("CTIA") Comments at 3-7; Cingular Wireless/BellSouth Corporation ("Cingular") Comments at 5-16; Verizon Wireless Comments at 1; and Motorola Comments at 9-10.

[3] As Sprint and others explained in the Interference Temperature docket, the concept for higher-powered unlicensed device operations in licensed bands – including open-loop, listen-before-talk constructs – suffer from numerous defects, including failure to measure the actual RF signal power experienced by victim licensed receivers; failure to account for path loss between the unlicensed transmitter and victim licensed receivers; failure to account for hidden node problems; failure to explain how the technical complexities involved in these theories of autonomous unlicensed operation in licensed bands could practically be implemented in real time on a real-world scale involving tens if not hundreds of unlicensed devices and licensed receivers, all moving simultaneously in varying regions having varying interference characteristics. *See* Sprint Comments, ET Docket No. 03-237, at 21-32 and 38-46. *See also* Motorola Comments, ET Docket No. 03-237 at 11-15; V-Comm Comments, ET Docket No. 03-237 at 30-32, 47-51; IEEE 802 Comments, ET Docket No. 03-237 at ¶ 19; Ericsson Comments, ET Docket No. 03-237 at 14-19; WCA Comments, ET Docket No. 03-237 at 18-22.

ceeding by Telcordia Technologies, Inc.[4] These technical concerns have been echoed by various commenters in the instant proceeding as well.[5] As Motorola points out:

> [A] host of challenges such as antenna shadowing, path loss uncertainty, varying antenna patterns, varying levels of detector sensitivity, and incompatible transmission formats, all combine to make it impossible to predict whether measurements accurately reflect radio activity in a given radio environment.[6]

Further, as pointed out by Nokia:

> Implementing advanced cognitive radio technologies, which are not fully mature or tested, as an interference management technique risks introducing unacceptable levels of interference into licensed bands. In the case of mobile networks that are particularly susceptible to interference, the negative impacts include reduced network coverage and capacity as well as a negative impact on price, size and power consumption of equipment.[7]

Faced with these well-documented technical obstacles, Sprint agrees with Motorola's conclusion that it is "not appropriate to consider bands used for CMRS for non-voluntary use by cognitive radio devices."[8]

In addition to technical concerns, Sprint shares the Commission's concerns regarding "the potential for parties to make unauthorized changes to software programmable radios after they are manufactured and first sold which could result in harmful interference to authorized services."[9] As CTIA and others caution, the Commission must ensure that there is some mechanism to prevent tampering and unsanctioned use of any cognitive radio operations it

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[4] *See* Dr. Jay E. Padgett and Dr. Robert A. Ziegler, Telcordia Technologies, Inc., *Analysis of "Interference Temperature to Support Spectrum Sharing Between Licensed Services and Unlicensed Devices* (April 2004)("Telcordia Report"), appended as Attachment A.

[5] *See*, *e.g.*, WCA Comments at 8-9; Verizon Comments at 4-5; Cingular Comments at 5-16; Motorola Comments at 7-14; V-COMM, L.L.C. Comments at 24-52.

[6] Motorola Comments at 10. See also Nextel Comments at 4; WCA Comments at 8-9.

[7] Nokia Comments at 2.

[8] Motorola Comments at 9-10.

[9] NPRM at ¶ 84. *See also* WCA Comments at n.7.

authorizes.[10] The suggestions of some commenters that propose tight restrictions only if interference problems arise should be rejected, for as history shows, the difficulties in identifying unlicensed sources of interference are exceeded only by the difficulties in remedying such interference.[11] In this regard, Sprint agrees with Nextel that "[t]he inherent ability of CR and SDR devices to be intentionally configured to circumvent existing spectrum use restrictions is an additional reason why they should not be deployed in CMRS bands, except by the licensees themselves."[12]

Ultimately, Sprint agrees with the various commenters that cognitive radio technologies are best utilized in licensed spectrum to facilitate spectrum leasing activities.[13] Sprint has demonstrated that limiting access to licensed spectrum by unlicensed "opportunistic" third parties to secondary market mechanisms is a superior option to a government-imposed, spectrum easement approach.[14] The benefit of following a secondary market approach is that it allows the licensee

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[10] *See, e.g.*, CTIA Comments at 9-11; National Public Safety Telecommunications Council ("NPSTC") Comments at 8-9.

[11] As the FCC acknowledged in addressing harmful interference caused by Part 15 radar detectors to very small aperture satellite terminals ("VSATs") in the 11.7-12.2 GHz band, "[I]dentifying each individual source of interference from [these] radar detectors is not practical for [the victim service] because these devices are mobile and therefore interfere intermittently. Further, these interference sources are not under the control of the [victim service operator], so in most cases it is not possible for the [victim service operator] to remedy the interference even if the source could be identified." *Radar Detector/VSAT Interference Order*, 17 FCC Rcd 14063, 14067 ¶ 11 (2002). Indeed, because neither the manufacturer nor the FCC exercised control over the radar detectors that had already been marketed, the FCC's solution of modifying the radar detector rules was only applied on a prospective basis, leaving untold numbers of interference-causing devices roaming throughout the U.S. Similarly, as the Spectrum Policy Task Force ("SPTF") recognized, once unlicensed devices enter the marketplace, "it may be difficult legally or politically to shut down their operations even if they begin to cause interference or otherwise limit the licensed user's flexibility." SPTF Report, ET Docket No. 02-135, at 58 (Nov. 2002).

[12] Nextel Comments at 7.

[13] *See, e.g.*, WCA Comments at 11-15; Verizon Comments at 9-10; Nextel Comments at 3-4; CTIA Comments at 7-8; TIA Comments at 5-6; Cingular Comments at 4-5.

[14] *See* Sprint Comments, WT Docket No. 00-230 (Dec. 5, 2003); Sprint Comments, WT Docket 03-66, at 7-15 (Sept. 8, 2003); Sprint Comments, ET Docket 02-135, at 17-21 (July 8, 2002); Sprint Reply Com-

to establish parameters for non-interfering operation by the unlicensed devices in its licensed area, based upon the specifications of both the unlicensed devices and the licensee's network. As Cingular points out, "[t]hrough the terms of the contract, the licensee would determine the type of interference, if any, that the lessee could cause, and the licensee would then be in a position to manage the effects of that interference through its own network design and operational parameters. Thus, the licensee would be able to balance the cost of managing such interference against the increased economic utility of the license resulting from the lease."[15]

III. THE FCC SHOULD NOT PURSUE OR ADOPT GENERAL INCREASES IN POWER FOR UNLICENSED DEVICE OPERATIONS

Sprint agrees with the many commenters who opposed the NPRM's general queries as to whether higher power operation should be permitted through other changes to the Part 15 rules.[16] First, irrespective of whether the NPRM's specific proposals for higher powered operations by cognitive radios under Rules 15.247 and 15.249 should be pursued at all – and a significant number of comments suggest otherwise – there is no basis for extending those operations beyond the ISM bands currently authorized under these rules.[17] The higher power operations permitted

ments, ET Docket 02-135, at 4-9 (July 23, 2002); Sprint Reply Comments, ET Docket 02-135, at 13-16 (. 27, 2003); Sprint Reply Comments, ET Docket 02-380, at 1-2 (May 22, 2003)..

[15] Cingular Comments at 4. *See also* CTIA Comments at 7-8; Nextel Comments at 4; WCA Comments at 11-15. Indeed, the Spectrum Policy Task Force recommended that the FCC focus on the use of secondary markets over underlay (or easements-based) models as an approach to enhancing unlicensed spectrum because the secondary markets model "takes advantage of the flexibility and adaptability of the market to solve access problems" and better avoids the technical uncertainties and potential pitfalls associated with easement-based approaches. SPTF Report at 56-58. In fact, the Task Force concluded that the secondary market approach has "significant potential to foster opportunistic technologies, such as agile-frequency-hopping radios, software defined radios, and adaptive antennas, at reasonable transaction costs." *Id*.

[16] *See, e.g.*, NPSTC Comments at 12-13; CTIA Comments at 5; Verizon Comments at 6; Ericsson Comments at 14-17.

[17] It is unclear whether the NPRM at ¶ 40 is requesting comment on whether the higher-power cognitive radio operations under Rules 15.247 and 15.249 should be permitted in every frequency band listed in

for spread spectrum devices under Rules 15.247 and 15.249 were confined to the ISM bands in large part because ISM devices (themselves unlicensed) were deemed to be generally unsusceptible to interference from other devices due to their robust design (and lack of in-band power limits). That deciding factor, however, simply does not apply in most, if not all, CMRS and other licensed spectrum.

Second, there is no basis for making general increases in the radiated emission limits set forth in Rule 15.209.[18] As the Commission has explained on several occasions, "the most basic principle of Part 15 operation is the requirement to function in a non-interfering manner in the midst of licensed devices."[19] However, the single act of arbitrarily raising the radiated emissions limits in Rule 15.209 – which apply throughout virtually the entire electromagnetic spectrum – could expose multiple licensees in multiple licensed services throughout multiple frequency bands throughout the spectrum to harmful interference.[20] As Verizon observes, "CMRS licensees have repeatedly placed evidence on the record that shows that their systems . . . are very sensitive to external interference from sources such as unlicensed devices."[21] In fact, in the Interference Temperature proceeding, commenters showed that allowing new RF signal power

those sections or whether such higher-powered operations should be permitted pursuant to those sections but extended to all frequency bands. Sprint opposes the latter.

[18] *See* NPRM at ¶ 41.

[19] *See Spread Spectrum Devices*, 15 FCC Rcd. 16244, 16252 ¶ 25 (2000). *See also Certification of Equipment in the 24.05 - 24.25 GHz Band*, 16 FCC Rcd 22337 ¶ 2 (2001).

[20] And as the Statewide Wireless Network, New York State Office for Technology ("NYS") observes, "Increasing power levels from such devices runs the risk of making it virtually impossible to identify the source of interference." NYS Comments at 12. *See also infra* at n.11.

[21] Verizon Comments at 6.

contributions to the existing noise floor in CDMA bands would result in a correspondingly substantial degradation to system capacity and coverage.[22] As Ericsson observes:

> At this time, cognitive radios have not matured sufficiently to allow high-powered operation without creating additional sources of interference. Therefore, increasing output power in unlicensed bands would likely create additional congestion and introduce additional sources of interference to co- or adjacent band operators.[23]

Finally, any increases to power limits for other specific categories of Part 15-regulated devices can only be examined, if at all, on a category-by-category basis.

IV. OUT-OF-BAND EMISSION LIMITS OF COGNITIVE RADIO DEVICES MUST NOT EXCEED THE LIMITS CURRENTLY ALLOWED UNDER THE FCC RULES

As discussed above, there is considerable opposition to the NPRM's specific proposal to permit higher-powered cognitive radio devices in the ISM bands pursuant to Rules 15.247 and 15.249. For example, as Nokia indicates:

> There is significant potential for unlicensed devices operating at higher power levels to increase both in-band and out-of-band interference to licensed networks such as CMRS, particularly if they are deployed ubiquitously. This increased interference could result in lost coverage and reduced network capacity for licensed networks such as CMRS, particularly at the edge of these licensed networks where it

[22] *See, e.g.*, Qualcomm Comments, ET Docket 03-237 at 7-8 (CDMA network operator would lose 10 to 15 percent of its existing network coverage by a 1 dB increase in the noise floor caused by Interference Temperature ("ITemp") devices. Alternatively, the network operator would have to attempt to increase its number of cell sites by 12 to 17 percent simply to maintain its existing coverage.), and 10-11 (Subscribers owning CDMA handsets would encounter a decrease in their handset battery lives of 20 percent or more.); Lucent Comments at 3 (If ITemp level was set around the current receiver noise floor (–109 dBm), a CDMA network operator would lose either 30 percent of its existing coverage or about 80 percent of its network capacity.); AT&T Wireless Comments at 17-18 (EDGE network operator would lose approximately 15 percent of its coverage area by a 1 dB degradation of the noise floor – or it would be required to attempt to add 17 percent more cell sites in order to maintain existing coverage), and 18-19 (GSM network operator serving an urban area would lose approximately 25 percent of its capacity from a 1 dB increase in the noise floor – or it would be required to attempt to add 33 percent more cell sites in order to maintain existing capacity levels.); Motorola Comments, Appendix A at A02 (W-CDMA network operator would lose 10 percent of its capacity by a 1 dB increase in the noise floor.).

[23] Ericsson Comments at 14.

> is anticipated that areas of "limited spectrum use" would exist. Mobile networks are more vulnerable to interference than other systems due in part to their wide-coverage areas.[24]

Nokia ultimately concludes that the NPRM's cognitive radio proposal "is not ready for implementation at this time."[25]

Similarly, TIA observes that "little technical work and testing has been conducted on this proposal and therefore it is difficult to estimate its impact."[26] Ericsson suggests that the NPRM's proposed rules could impose significant interference upon existing unlicensed devices in the ISM bands.[27] Indeed, if the cognitive radios are operating at six times the power of ordinary spread spectrum devices operating under Rules 15.247 and 15.249, it seems likely that the ability of the cognitive radio to interfere with those ordinary unlicensed spread spectrum devices will occur well before the ability of the cognitive radio to actually detect their transmissions. Even limited to the ISM bands, the comments raise sufficient concerns regarding the NPRM's listen-before-talk cognitive radio proposal that it should be thoroughly tested and shown not to impose interference upon licensed CMRS systems before formal adoption into the FCC rules.

In any event, Sprint agrees with the WCA that if the Commission allows cognitive radios to operate at six times (or any other multiple of) the power limit set forth in Rule 15.247, it must ensure that the out-of-band emissions of those cognitive radio devices are no greater than what is currently allowed for ordinary (*i.e.*, non-cognitive) devices under this rule.[28] As the NPRM points out, the out-of-band emissions limit in Rule 15.247 is a function of the output power and,

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[24] Nokia Comments at 3.

[25] *Id.*

[26] TIA Comments at 5.

[27] Ericsson Comments at 15-16.

[28] *See* WCA Comments at 17.

thus, would increase correspondingly as the cognitive radio device increases its output power by up to six times the output power limit set forth in Rule 15.247.[29] The NPRM's justifications for allowing cognitive radio devices to operate at six times the current power limit in Rule 15.247 (and 15.249) are (i) the assumed ability of the cognitive radio to determine spectrum occupancy on a given ISM band covered by that section and (ii) the general resistance of ISM equipment to interference.[30] Neither of these premises have any connection or validity with respect to emissions that fall *outside* of the ISM bands covered by those rule sections. Indeed, the *only* reason for allowing cognitive radios operating under Rule 15.247 to emit higher out-of-band emissions than non-cognitive radios is that the requirements of that rule happen to be constructed so that the out-of-band emissions are a function of output power.[31] Licensees adjacent to and nearby the ISM bands, such as Instructional Television Fixed Service and the Multipoint Distribution Service licensees in the 2500-2690 MHz band, should not be exposed to such an additional and ubiquitous source of interference whose effects have neither been examined nor even acknowledged in the NPRM.

V. CONCLUSION

For the foregoing reasons, Sprint respectfully requests that the Commission: (1) not pursue or authorize use of cognitive radio technologies to enable non-voluntary third party access to licensed CMRS spectrum; (2) not pursue or authorize any general increases in the power limits under Rule 15.209 or any other rule not identified in the NPRM; and (3) not adopt the listen-

[29] *See* NPRM at ¶ 42.

[30] *See* NPRM at ¶¶ 37 and 39.

[31] The arbitrariness of following Section 15.247's construct for out-of-band emissions is clear from the fact that cognitive radios operating in *identical* ISM spectrum at basically the *same* elevated output power

before-talk cognitive radio concept proposed in the NPRM unless and until it has been thoroughly tested and shown not to impose interference upon licensed CMRS systems, but irrespective of how the Commission proceeds, it must adjust the NPRM's proposed rules so that the out-of-band emissions of cognitive radio devices operating under Rule 15.247 are no greater than what is currently allowed under that rule for non-cognitive devices.

Respectfully submitted,

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levels under Section 15.249 would not be permitted to increase their the out-of-band emissions beyond what is allowed for non-cognitive devices.